

JPRS 80309

12 March 1982

# USSR Report

EARTH SCIENCES

No. 20



FOREIGN BROADCAST INFORMATION SERVICE

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USSR REPORT  
EARTH SCIENCES

No. 20

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## METEOROLOGY

### CLIMATE IN PAST AND FUTURE

Moscow ZEMLYA I VSELENNAYA in Russian No 6, Nov-Dec 81 pp 19-22

BUDYKO, M. I., corresponding member, USSR Academy of Sciences

[Abstract] A considerable number of factors exert a substantial influence on the earth's climate. One of the most important is variations in atmospheric CO<sub>2</sub> concentration. The quantity of atmospheric CO<sub>2</sub> has increased in periods of strong volcanic activity. This is attributable to the fact that much CO<sub>2</sub> is released during strong volcanic eruptions. At the end of the Mesozoic there was a tendency to a decrease in atmospheric CO<sub>2</sub> and in the modern epoch its concentration is only about 0.03% of the total atmospheric volume. This is several times less than the CO<sub>2</sub> concentration in the Phanerozoic. There is reason to believe that a decrease in the CO<sub>2</sub> concentration in the Cenozoic was the main reason for the change in climate in the direction of a cooling and the appearance of glaciers in the high latitudes. It has been demonstrated that the polar ice arising as a result of global cooling favors an additional decrease in ambient temperature. It has a great reflectivity for solar radiation and therefore less radiation is absorbed in the ice zone and the air temperature decreases. Ice therefore is not only a result of the cooling of climate but to some degree also its cause. Even with relatively small changes in the factors influencing climate the boundaries of the ice cover on the land and in the oceans can shift by thousands of kilometers. In the remote past, either when there was no polar ice at all or there was relatively little ice periodic variations of solar radiation could not cause appreciable climatic changes. Variations in atmospheric transparency exert a very great influence on climatic conditions. One of the principal reasons for an increase in the quantity of atmospheric aerosol is volcanic eruptions. With an intensification of volcanism atmospheric transparency decreases, resulting in a decrease in the quantity of solar radiation reaching the earth's surface and the temperature of the lower air layers decreases. During periods with lesser volcanism the atmosphere is purified of aerosol and air temperature increases. Climatic changes in the northern hemisphere are such that from the end of the 19th century to the 1930's the air temperature increased by approximately 0.4-0.6°C. After the 1930's the warming was replaced by cooling, during which by the 1960's the temperature dropped by approximately 0.3°, followed by a new warming. The reason for brief temperature variations (and in part, longer changes) is made clear by a comparison of the curve of changes in mean temperature and the curve of variations in atmospheric transparency. This comparison reveals that a transparency increase usually leads to a temperature increase whereas a transparency decrease

results in a lowering of temperature. Frequently temperature changes lag somewhat behind transparency variations. This is due to the earth's thermal inertia. Man's economic activity exerts a significant effect on climate. This was manifested even thousands of years ago in connection with the development of irrigation and cutting of trees; later the building of cities, drainage work, and the planting of trees also exerted an effect. Such works of man had a relatively local effect. Now, with the rapid development of industry and power production, there may well be a climatic change on a planetary scale. The principal reason for these changes will be gradual heating of the atmosphere due to the increasing CO<sub>2</sub> concentration. Since the middle of the last century the CO<sub>2</sub> concentration has increased by approximately 15%. The main reason for this increase is the combustion of ever-increasing quantities of coal and petroleum. Approximately half the total CO<sub>2</sub> mass formed during fuel combustion is held in the atmosphere and the other half is dissolved in the waters of the world ocean. The increase in CO<sub>2</sub> mass has already led to an increase in mean air temperature by approximately 0.5°. This is a small value for the time being comparable with variations in mean temperature occurring due to changes in atmospheric transparency. But a further development of the power industry, based on use of carbon fuel, can lead to far stronger heating. Figures 4.

[67-5303]

## OCEANOGRAPHY

### NEW 'VITYAZ'' ON FIRST VOYAGE

Moscow PRAVDA in Russian 3 Jan 82 p 6

[Article by A. Androshin: "Prologue to Voyage"]

[Excerpt] The ship, which in December joined the scientific research fleet of our country, has met its first New Year. On the eve of the holiday it departed from Kaliningrad, where it was temporarily moored, for Novorossiysk. The passage around Europe was a singular prologue for the first voyage. It will begin in mid-January. On this voyage the participants on the expedition will not only make an examination of the new equipment carried aboard the steamer, but will also solve a number of reasearch tasks.

"In particular, we are planning to work some near Cyprus, as well as in the neighborhood of Ampere seamount, located at the threshold of Gibraltar," stated Professor V. Yastrebov, deputy director of the Institute of Oceanology of the USSR Academy of Sciences. "Extremely interesting, unusual structures were discovered on the peak of this mount several years ago using underwater cameras. In their study some specialists postulated that these constituted the remains of ancient settlements which at some unrecorded time, during the last global thawing of the glaciers, when the ocean level rose a hundred meters, were submerged on the bottom, like the legendary Atlantis. In the opinion of other researchers, the structures are of geological origin. We hope to solve this dispute when we take ground samples from the bottom and will also attempt to examine it through the windows of the 'Argus' descent vehicle. And the divers will 'feel' the objects on the top of the Ampere seamount."

The "Vityaz'" is beautifully adapted for the solution of such problems. For the first time Soviet specialists are able to use it for carrying out multisided investigations in the ocean with the use of divers and underwater vehicles. A hyperbaric complex has been created in the ship's hold; it is rated for a depth as great as 250 meters. It includes a pressure chamber where men can undergo decompression only once after completion of a scientific program. When it is necessary, the aquanauts enter a bell and are lowered in this way to the stipulated depth. Upon completion of each dive they will return to the ship. After docking of the bell with the pressure chamber they will pass into a dry compartment and remain there to the end of the work at a pressure up to 25 atmospheres.



In the hold of the "Vityaz'" there is a sort of hangar for the underwater manned vehicle. The special platform on which it rests is easily raised to the deck level. Plans also call for the extensive use of towed and telecontrolled vehicles. To be sure, there are laboratories aboard the ship, such as biological, hydrological and geophysical. An electronic computer intended for the processing of data is installed there.

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CSO: 1865/78

## NOTES ON SOVIET OCEANOGRAPHIC WORK

Moscow KOMSOMOL'SKAYA PRAVDA in Russian 13 Nov 81 p 4

[Interview with various Soviet oceanographers at roundtable discussion]

[Excerpts] [Question for Leonid Maksimovich Brekhovskikh, academician-secretary of the Department of Oceanology, Physics of the Atmosphere and Geography, USSR Academy of Sciences] The ocean affords a great many problems. Could you mention the problem of the greatest priority?

[Answer] I would mention three scientific directions of equal importance in investigation of the world ocean. In particular, it is necessary to study the interaction between the ocean and the atmosphere. It is precisely these processes which determine weather on the planet. Long-range forecasting involves solution of a great many vitally important problems: from the health of man to guaranteed yields. The second direction is study of geological structures of the bottom in order to determine more precisely the history of development of the earth and the patterns of mineral distribution. This will help in creating a theoretical scientific basis for use of the mineral resources of the world ocean. And third: study of the biological life of the world ocean at all levels -- from the simplest microbes to warm-blooded animals. The ocean is a challenge to science. We are at the beginning of a difficult path to learning about it. There is no way in which man can live on a planet which is 2/3 covered with water and know so little about it.

[Answer by Artem Aramovich Geodekyan, corresponding member, USSR Academy of Sciences] During the last half-century scientists have been actively discussing the problems involved in use of the mineral resources of the world ocean. The world ocean contains all the elements characteristic for the earth's crust. And water itself is a virtually inexhaustible source of mineral raw material. The terrestrial reserves of mineral raw material are being rapidly exhausted. During the 20th century alone mankind has expended more minerals than during the 19 centuries which preceded it. And this rate is increasing, forming a shortage of many minerals. And the search for them on the land is becoming more and more costly. However, the world ocean is a storehouse of all kinds of treasures. Water itself contains up to 70 elements in the Mendeleyev table. The content of many elements, to be sure, is small, but this is a ready-made solution in an unlimited quantity. According to estimates of foreign specialists, the extraction of uranium from sea water is equally advantageous from the economic point of view as the exploitation of poor ores on the land, which even now are coming into use in industry. But in the world ocean there are also placers, such as the diamond-bearing beaches of Africa, the

gold-bearing plateau of Alaska and the phosphorus-bearing coasts of California. But deposits of petroleum and gas are now most important. More than half the world reserves of petroleum and gas are hidden in the ocean. This is only what has been explored. And is there an equal quantity awaiting discovery?

[Question] Any geological investigation has an end goal -- discovery of an industrial deposit and a determination of how advantageous it is to extract the mineral. What can marine geologists offer for practical purposes in the immediate future?

[Answer] Already in the 1950's Soviet petroleum workers were the first in the world to begin to produce petroleum from beneath the waters of the Caspian Sea and now more than 100 countries are engaged in a search for and exploration of petroleum and gas beneath the sea. Not only are they engaged in this work, but at sea they are producing more than 20% of the entire world volume of petroleum output. According to UN data, sea deposits contain more than 60% of the world reserves of petroleum and gas. Successful exploration work in the waters of the world ocean has led to the discovery of very rich deposits of petroleum and gas. The discovery of petroleum in the North Sea, for example, has transformed Great Britain from an importer to an exporter of petroleum. Even now it can be said with assurance that the greatest petroleum and gas resources are "tied in" for the most part to the zones of joining of the continents and oceans or former intracontinental seas. The shelf zones of the seas and oceans are particularly promising.

[Question] What is the fundamental difference between marine geology and the geology of the land?

[Answer] It differs in a broader point of view not only with respect to the geological past of the earth, but also in specific geological facts. After all, at sea any information is obtained from the bottom by difficult and stubborn work. This information is not so abundant that one can make an unambiguous judgment concerning minerals. In actuality we have not gone beyond the stage of collection and analysis of facts. For the time being we are investigating the bottom with the accuracy of a colleagues on the land who collect rock samples in rucksacks or make studies from an aircraft. Under water we cannot inspect geological shows which on land are used in judging geological structure. But I can say definitely: there is no method which can replace a specialist who always sees broader and deeper. The ability to see the same as on the land is the dream of the marine geologist. A general picture of structure of the bottom and the underlying layers can be provided by different geophysical methods; the water layer can be penetrated by ultrasound; but the taking of rock samples from the bottom and detailed investigations of the characteristic geological elements for the time being is scarcely possible without man's descent. I will not now speak of the mineral production processes. The presence of man on the bottom is inevitable.

[Question] What is the current status of use of underwater vehicles?

[Answer by Vyacheslav Semenovitch Yastrebov] The evolution of underwater vehicles was dictated by life itself. At shallow depths we already have learned to solve very simple problems: the taking of bottom samples and water samples, photographing of flora and fauna. Very simple instruments are used for this purpose or man himself descends to the bottom in light diving gear. At greater depths there must be

more reliable life support -- a rigid diving suit, underwater vehicle, submarine of the Cousteau diving saucer type or Soviet-produced craft. At great depths stronger vehicles have come into use, such as the "Arkhimed," "Triyest" and "Siana" and the submarines "Alvin," "Alyuminant," "Severyanka" and others. All these means make it possible not only to look out the windows at the surrounding environment, but also to take samples of rocks, ores and animals, as well as samples of water. Abroad underwater vehicles have become narrowly specialized. We, however, are attempting to endow them with broad capabilities. In principle, the lunokhod (lunar cross-country vehicle) differs little from an underwater craft. In general, the creators of underwater apparatus are faced with problems similar to those faced by the designers of space systems. True, in space a vehicle operates at minus one atmosphere, whereas we work at up to 1000 atmospheres. Underwater apparatus operates under more severe conditions. For the time being there are no such materials as will withstand the necessary loads. Rubber becomes like ebonite, fluoroplastic flows and it is a real problem to create a system of gaskets. Water is aggressive and therefore corrosion is a curse; everything malfunctions -- from iron to electronic systems. Another serious problem is the supply of electric current. In space there are solar cells, but where can power be obtained under water? It is difficult to take a power source along because it is unwieldy and it is technically difficult to supply it from above.

It is better to have a combination of means. Depending on the circumstances and tasks -- select what is necessary. On the scientific research ship "Vityaz'," which is under construction, all the necessary complex of apparatus will be brought together. Particularly promising are telecontrolled underwater vehicles which were created for different depths: "Manta-1.5" -- up to 1.5 km, "Zvuk-4" -- up to 2 km, "Krab" -- up to 4 km, and work is proceeding on a vehicle for work at a depth of 6 km. Virtually no one works at a greater depth. The experimental work carried out in the Black Sea has shown that these vehicles can be used successfully in geological, geochemical and geophysical investigations. They can inspect the bottom surface by means of television apparatus and carry out the purposeful collection of rock and water samples, study definite bottom forms, such as fissures and faults, and also investigate sediments. Telecontrolled vehicles on a practical basis can completely replace man on the bottom, even including identification of features and analysis of information.

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CSO: 1865/65

## SOVIET-CUBAN HURRICANE STUDY COMPLETED

[Unsigned article: "Cooperation of Scientists"]

[Text] The next stage in the joint program for the study of hurricanes in the Caribbean Sea has been completed by the scientists of the USSR and the Academy of Sciences of Cuba. The surface meteorological stations of Cuba also worked in close collaboration with the floating laboratories "Akademik Korolev" and "Priboy," which are returning to Vladivostok.

The Caribbean Sea is the singular weather "kitchen" of the Atlantic. Powerful hurricanes are generated there (during 90 years a total of 761 have been registered). These exert an active influence on the weather of virtually all regions of the planet.

The studies were carried out under the program "Tayfun-81" in accordance with the Soviet-Cuban agreement on scientific-technical cooperation. In the Caribbean Sea it was possible to collect much material refining the reasons for the generation of hurricanes. Using radiosondes it was possible to study the upper layers of the atmosphere and information was obtained with bathometer-sondes in the sea depths. For the first time systematized aerological and hydrometeorological information was obtained which is necessary for computations of the energy balance in the entire Caribbean basin.

5303

CSO: 1865/61



## MEASUREMENTS OF GAS BUBBLE CONCENTRATION IN SEA SURFACE LAYER

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 260, No 6, 1981 (manuscript received 5 May 81) pp 1474-1476

SANDLER, B. M., SELIVANOVSKIY, D. A. and SOKOLOV, A. Yu., Institute of Applied Physics, USSR Academy of Sciences, Gor'kiy

[Abstract] An experiment was carried out for detecting individual gas microbubbles in the sea surface layer and measurement of their concentration. The following measurement principle was employed: upon entering into the region of intersection of powerful ultrasonic beams with the frequencies  $F_1 > F_j > f_{res}$  ( $f_{res}$  is the resonance frequency of characteristic oscillations of a bubble) a gas microbubble emits an acoustic wave with the difference frequency  $f = F_1 - F_j$ . The instrument used was suspended to a cable connected to a shipboard recorder. The zone of intersection of the powerful ultrasonic beams is formed by three sound sources each 3 cm in diameter creating ultrasonic beams of the frequencies  $F_{1,2,3} = 1000, 1070, 1200$  KHz. Signals of the corresponding difference frequencies are registered in three registry channels with the frequencies  $f_{1,2,3} = 70, 130, 200$  KHz. The axes of the sources are mutually orthogonal; the distance from the point of intersection of the axes to each source is about 20 cm. The working zone (zone of coverage of the ultrasonic beams) has a volume  $20 \text{ cm}^3$ . Special hydrophones pick up sound waves with the frequencies  $f_{1,2,3}$  and  $F_{1,2,3}$ . The synchronous radiation of the frequencies  $F_{1,2,3}$  is by pulses with a duration of  $50 \mu\text{sec}$  and with a pulse repetition rate 400 Hz. Measurements were made from a drifting ship with the instrument at a stipulated depth for not less than 10 minutes. The concentration of gas bubbles was determined by counting the responses from individual bubbles and by measuring the volume of water investigated by the instrument during its flow through the region of intersection of ultrasound beams. It was found that in all variants of the experiment among the bubbles of undissolved gas in the sea surface layer there was a predominance of bubbles of the minimum size. The bubble concentration decreases with an increase in depth and increases with an increase in wind force, with a predominance of

bubbles of the minimum size persisting. The maximum bubble concentration detected in Amur Bay about 30 km from a river mouth is attributable to a great quantity of phytoplankton, producing gas bubbles, in the freshened sea water. Everywhere in the course of the experiment signals were received which could be classified as indicators of the existence of microbubbles with  $f_{res} = F_{1,2,3}$ , but the duration of the responses of these signals was considerably less than the time required for the passage of the bubbles through the working zone. This matter requires further study. The method is highly reliable in clarifying the dependence of bubble concentration on different factors, such as depth, meteorological conditions and presence of plankton. Tables 3; references 3: 2 Russian, 1 Western. [56-5303]

UDC 551.465.55:551.466.6

SPECTRAL DESCRIPTION OF SYNOPTIC VARIABILITY OF OCEAN CURRENTS ACCORDING TO 'POLIGON-70' AND 'POLIMODE' DATA

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 17, No 11, Nov 81 (manuscript received 9 Oct 80) pp 1191-1200

KONYAYEV, K. V. and SABININ, K. D., Acoustics Institute

[Abstract] The authors give the results of a spatial-temporal spectral analysis of synoptic variations of current velocity in hydrophysical polygons in the Atlantic ("Poligon-70" and "Polimode" experiments). The collected data indicate a stable character of synoptic variability of currents over a large area of the Atlantic Ocean. A comparison with the possible parameters of Rossby waves indicates a predominant role of the lower modes of these waves in the synoptic variability of currents. According to "Polimode" data, in the main thermocline it is quasiplane baroclinic Rossby waves of the first mode moving to the WSW and creating alternating streams of currents to the SSE and NNW which are most clearly expressed, with a characteristic wavelength of about 450 km, an observed period of about 85 days and a true period of about 150 days. Also clearly expressed are two quasiplane barotropic Rossby waves moving at a great angle to one another on the average to the west and creating circular eddies in a checkerboard pattern with a characteristic wavelength of 300-400 km, with an observed period of about 50 days and a true period of about 60 days. The synoptic movements at the 700-m horizon can be represented in the form of quasiplane waves, moving to the SW with a mean wavelength of about 500 km, and at the horizon 1,4000 m--in the form of almost circular eddies measuring 150 x 200 km, moving to the west. Figures 5; references 5: 3 Russian, 2 Western. [64-5303]

## POLARIZATION PARAMETERS OF CHARACTERISTIC RADIATION OF SEA SURFACE

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 17, No 11, Nov 81 (manuscript received 17 Dec 80) pp 1178-1183

MUKHAMEDYAROV, R. D. and TIMOFEEV, V. N.

[Abstract] This investigation of the polarization parameters of the characteristic radiation of elements of the sea surface, taking into account the angle of sighting, the angle between the direction of wave propagation and the direction of scanning and sea waves made it possible to draw the following conclusions. With an increase in the angle of sighting there is an increase in the mean degree of polarization of the characteristic radiation of the sea surface both in the presence and in the absence of petroleum on its surface. With an increase in the angle between the direction of propagation of sea waves and the scanning direction (as with a decrease in the dispersion of the slopes of sea surface elements) there is an increase in the probability density of the mean degree of polarization both in the presence and in the absence of petroleum on the water surface. The presence of a petroleum film is the reason for the increase in the degree of polarization of characteristic sea radiation. The absolute difference in the degree of polarization of radiation from the clean and petroleum-contaminated water surface increases with an increase in the angle of sighting. These findings make it possible to solve a number of problems of practical importance, especially the problem of detecting and determining the areas of petroleum contaminations of the sea surface by measuring the degree of polarization of its characteristic radiation and also the problem of making a statistical evaluation of the effectiveness in detecting petroleum films. Figures 4; tables 1; references: 10 Russian.  
[64-5303]

## INFLUENCE OF GEOMETRIC PARAMETERS OF LIDAR ON ECHO SIGNAL STRENGTH IN SOUNDING OF AQUEOUS MEDIA

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 17, No 11, Nov 81 (manuscript received 2 Jun 80, after revision 12 Aug 80)  
pp 1164-1167

BAULIN, Ye. V., DEMIDOV, A. A. and FADEYEV, V. V., Moscow State University

[Abstract] In earlier studies (D. N. Klyshko, et al., DOKL. AN SSSR, Vol 238, No 2, pp 320-323, 1978; A. A. Demidov, et al., VESTN. MGU: FIZ., ASTRON., No 4, pp 64-70, 1978) the authors, using a small-angle approximation, derived an expression for the strength of an echo signal registered by a laser sounder (lidar) during the sounding of natural water media. It follows from that expression that the strength of the echo signal is rather complexly dependent on the geometrical

parameters of the experiment, the most important of which include the base  $a$  between the axis of the laser beam and the optical axis of the detector and the distance  $b$  at the water surface between the laser ray and the optical axis of the detector. In the second of the above-mentioned studies an expression was derived for the optimum focal lengths of the optical systems of the laser and lidar detector. In a comparison of the experimentally registered echo signal strengths (with  $a = 30$  m) and the theoretically computed values for a coaxial lidar scheme ( $a = 0$ ,  $b = 0$ ) it was found that there is a discrepancy between these parameters. The necessity for optimizing the lidar parameters and accordingly increasing its response and effective range led to the formulation of the follow-up experiments described in this article. In this work a comparison was made of the experimental dependence of echo signal strength on the geometrical parameters of the sounding scheme. The investigations were made in the Phillippine Sea during a sea expedition. Remote laser sounding was with a laser spectrofluorimeter; distance to the water surface was about 10 m. The results revealed that the experimental dependence of echo signal strength on geometrical parameters qualitatively and quantitatively agrees quite well with the results of theory. The small discrepancy (by a factor 2-8) between the experimental and theoretical results and also the scatter of experimental data can be attributed to unmonitorable changes in the geometry of the experiments, state of the rotating mirror surface, presence of a special filter installed in front of the polychromator and conditions for passage of the ray through the water surface. Figures 5, tables 1; references 7: 4 Russian, 3 Western.  
[64-5303]

UDC 551.24(265)

#### NEW DATA ON DEEP STRUCTURE OF YAP TRENCH

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 261, No 3, 1981 (manuscript submitted 23 Apr 81) pp 715-719

KOSYGIN, Yu. A., academician, SERGEYEV, K. F., corresponding member, USSR Academy of Sciences, ANDREYEV, A. A., ANOSOV, G. I., UBLEVSKIY, A. A. and KRASNYY, M. L., Institute of Tectonics and Geophysics, Far Eastern Scientific Center, USSR Academy of Sciences, Khabarovsk, and Sakhalin Multidiscipline Scientific Research Institute, Far Eastern Scientific Center, USSR Academy of Sciences, Novoaleksandrovsk

[Abstract] As a result of the Pacific Ocean Geophysical Expedition carried out by the Far Eastern Scientific Center in 1978-1979 in the southern part of the Phillippine Sea information was obtained on the deep structure of trenches, especially the Yap Trench, which to a considerable degree makes it possible to upgrade concepts concerning their tectonic nature. The expedition was carried out on the "Morskoy Geofizik" and the "Fedor Matisen." The most important features investigated were the ocean area around the island arc and the Yap Trench and a small polygon in the neighborhood of the Mindinao Trench. The results of study of



the geophysical fields obtained in the course of the expedition considerably supplement the geological data obtained earlier on the 17th voyage of the "Dmitriy Mendeleyev" and the 54th voyage of the "Vityaz'." The results were used in constructing maps of the anomalous gravity field in the Faye and Bouguer reductions, curves of the anomalous magnetic field, two profiles run by the refracted waves method and four profiles run by the continuous seismic profiling method (Figures 1 and 2). The maximum values of the anomalous gravitational field in the Faye reduction are associated with bottom rises and islands; the minimum values are associated with the axial part of the trench. Since the region lacks unconsolidated and stratified deposits of significant thickness, the map of anomalies in the Bouguer reduction will reflect the behavior of the M discontinuity or other deep discontinuities. The collected data indicate a unity (in a physical sense) of the deep structure of the western and eastern sides of the Yap Trench and a predominance of transverse zonality in its deep structure. It was found that the Yap Trench does not penetrate deeper than the second layer of the oceanic crust, that is, a full section cannot be obtained within its limits. The morphological features and deep structure of the region of the Yap island system lead to the conclusion that the Yap Trench is superposed on a heterogeneous basement. Figures 2; references: 2 Russian. [71-5303]

UDC 551.463.681

#### FREQUENCY CHARACTERISTICS OF FLOAT WAVE RECORDER

Moscow OKEANOLOGIYA in Russian Vol 21, No 6, Nov-Dec 81 (manuscript received 18 Apr 80, after revision 1 Dec 80) pp 1128-1133

KOTT, Yu. P., Acoustics Institute imeni Akademik N. N. Andreyev

[Abstract] Since the introduction of spectral analysis methods into the study of sea waves requires the creation of measurement complexes linked to an electronic computer and having known frequency characteristics it is common to make use of the float wave recorder for wave measurements in the open sea. However, this instrument has had definite shortcomings. This article constitutes an investigation of the frequency characteristics of the float wave recorder described by the author earlier (OKEANOLOGIYA, Vol 12, No 6, pp 1117-1119, 1972) and its improved version in which use is made of a float of lesser size, a digital recorder and heterodyne conversion transducer tuned to the harmonic components of the frequency sensor signal. Since the direct measurement of the frequency characteristics of a float wave recorder is virtually impossible, computational expressions are derived which are checked using an indirect method based on statistical processing of data from in situ observations, involving averaged spectra of sea waves measured in the Atlantic Ocean, and the empirical Pierson-Moskovitz spectrum. The derived formulas are shown to be suitable for approximate computations. Figures 3, tables 1; references 10: 8 Russian, 2 Western. [75-5303]



## MINIATURIZED SEISMIC RADIO BUOY

Moscow OKEANOLOGIYA in Russian Vol 21, No 6, Nov-Dec 81 (manuscript received 14 Dec 79, after revision 27 Apr 81) pp 1125-1127

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[Abstract] Specialists at the Institute of Oceanology, USSR Academy of Sciences, have created several variants of models of a seismic buoy which have been successfully used on different expeditions. These radio buoys are intended for the reception of seismic oscillations propagating through a hydrochannel and their transformation to a form convenient for radio transmission to the ship. The apparatus carried aboard the ship ensures the reception of radio signals, their transformation into seismic oscillations and registry on high-speed automatic recorders and magnetic recorders. The excitation of elastic oscillations from the ship is also provided for. In the initial stages in the work the source of seismic waves was shots. Then, in connection with the broad introduction of pneumatic sources into the practice of seismic research, the method for work with radio buoys was automated. This made possible a substantial improvement in the quality of the collected data. The seismic radio buoy includes the following electronic units: hydrophone preamplifier, direct conversion block and transmitter. Microcircuits can in principle be used in all the enumerated units. However, this is not always feasible and justified. A figure shows the electric circuitry of a block in which microcircuits are employed. However, in the hydrophone preamplifier use is made of a stage with one field transistor and the use of microcircuits can only increase the cost. The transmitter requires powerful high-frequency microcircuits whose extensive use for the time being is limited. The described direct conversion block with microcircuits for a small seismic radio buoy ensures amplification and transformation of the frequency band in the limits 4-200 Hz at the level 6 db. The amplification factor of the hydrophone preamplifier is 10-12. The hydrophone response when using a pressure detector is  $14-21 \mu\text{V/Pa}$ . The working range of temperatures is  $+5-40^\circ\text{C}$ . The power voltage of the unit is 12 V. The dimensions of the unit, including the screen, is  $100 \times 55 \times 25$  mm and the mass is not greater than 165 g. The miniaturized radio buoy was experimentally checked on the 24th voyage of the scientific research ship "Akademik Kurchatov" and on several voyages of the "Dmitriy Mendeleev." Figures 1; references 10: 6 Russian, 4 Western.

[75-5303]

## USE OF SECTIONAL GLASS SHELLS IN CREATING ABYSSAL SELF-CONTAINED INSTRUMENTS FOR OCEANIC RESEARCH

Moscow OKEANOLOGIYA in Russian Vol 21, Nov 6, Nov-Dec 81 (manuscript received 8 Sep 80, after revision 9 Mar 81) pp 1118-1124

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[Abstract] The effectiveness of use of self-contained instruments and apparatus of the automatically floating-up type increases with an increase in the working depth of the ocean. This determines the special requirements on the design of self-contained instruments and apparatus related, in particular, to high hydrostatic pressure acting on the self-contained instruments and apparatus when they attain working depths. Glass plastic is one of the types of construction materials which can be used successfully in creating sealed shells for abyssal instruments and apparatus. Such shells have the following principal properties: relatively high strength and resistance to destruction under high external pressure, brittleness of material, light transparency, magnetic transparency and radio transparency, as well as a relatively low specific gravity of the material. The authors examine several examples of possible use of these durable glass-plastic shells. 1. Float elements used in the supporting and raising of deep-water trawls and also drifting and submerged buoy stations and as floats for autonomous samplers. Brittleness of the material for such float elements in this case is a negative property. 2. Durable sealed containers for sensors and recorders of bottom geophysical and hydrophysical stations--still in the stage of development and experimental checking. Brittleness is also a restraining factor in their practical use; valuable instruments can be lost if the instrument container is fractured. 3. Durable sealed containers for light beacons made from glass plastic retain a virtually constant light transparency during relatively prolonged operation under high hydrostatic pressure. 4. Durable sealed containers for radio beacons have come into broad practical use in designs of Soviet-produced autonomous samplers. Radio transparency in this case can be a decisive factor. 5. Durable sealed containers for hydroacoustic beacons and transponders are not yet in use, but no significant problems stand in the way of their use. 6. Special power flasks for the working (actuating) organs of samplers, made from such glass-plastic shells, can be employed successfully in the underwater destruction of bedrock outcrops on the bottom and for sampling bedrock. 7. Special power flasks for sources of elastic oscillations made using such shells have great possibilities in deep seismic sounding and seismoacoustic investigations of the world ocean, but investigations of their potential are still in the experimental stage. The article discusses some aspects of the technology involved in production of these shells and some tests which have been made of strength and other properties. Figures 4, tables 1; references: 5 Russian.

[75-5303]

## HYDROOPTICAL INVESTIGATIONS USING 'ARGUS' SELF-CONTAINED UNDERWATER VEHICLE

Moscow OKEANOLOGIYA in Russian Vol 21, No 6, Nov-Dec 81 (manuscript received 10 Nov 80, after revision 6 Apr 81) pp 1109-1112

NIKOLAYEV, V. P., YAKUBENKO, V. G., ZHIL'TSOV, A. A., PROKOPOV, O. I. and BULYGA, V. V., Southern Division, Institute of Oceanology imeni P. P. Shirshov, USSR Academy of Sciences, Moscow

[Abstract] Six dives of the manned self-contained underwater vehicle "Argus" took place during June-July 1980 along the Caucasus shore of the Black Sea. The purpose was the carrying out of hydrooptical investigations in accordance with the following program: 1) measurements of sunlight brightness at different depths in the entire visible spectral range; 2) study of the spatial-temporal variability of sea water transparency; 3) measurements of transparency of bottom layers on the continental slope. Measurements of sunlight brightness were made using a spectrophotometer designed on the basis of a monochromator with a diffraction grating. The spectrophotometer was mounted within the vehicle under the upper window. The vertical distribution of sea water transparency was measured using a transparency meter-stratificator lowered over the side of an auxiliary ship. The stratificator was supplied with temperature and depth sensors. A remotely controllable bathometer for taking water samples was mounted on the stratificator housing. Figure 1 shows the results of measurements of the spectral distribution of relative brightness  $L(\lambda)$  of descending solar radiation for different depths in the visible part of the spectrum. A comparison of the data in the table and the vertical distribution of water transparency (Fig. 2) shows that the selective attenuation of light by sea water near  $\lambda = 520$  nm is significant in layers of reduced transparency. It is characteristic that the spectral curves of the index of light attenuation for water samples taken from the turbidity layers virtually do not differ from one another in shape but differ substantially from the corresponding curve for waters of high transparency. This difference is as follows: 1) the appearance on the curves corresponding to turbid water of a maximum near  $\lambda = 520$  nm and 2) a decrease in the difference between the values of the attenuation index for  $\lambda = 424$  nm and  $\lambda = 670$  nm with transition from transparent to turbid water. Figure 4 shows spectra' curves of the light attenuation index  $\lambda$  for water samples taken from the surface at different distances from the shore soon after the ending of storm waves. This figure demonstrates a continuous increase in water transparency in the surface layer with increasing distance from the shore. Near  $\lambda = 520$  nm there was a clearly expressed zone of increased attenuation of light by sea water, constituting a layer of reduced transparency. There was a thin surface layer of turbid heated water, an intermediate more transparent layer and colder water and two clearly expressed turbidity layers. The experience gained in the dives confirmed the feasibility of using self-contained underwater craft for hydrooptical measurements. Figures 4, tables 1; references 2.

[75-5303]

## METHODS FOR IMPLEMENTING GEOLOGICAL RESEARCH USING 'PAYSIS-XI' UNDERWATER VEHICLE IN RED SEA EXPEDITION

Moscow OKEANOLOGIYA in Russian Vol 21, No 6, Nov-Dec 81 (manuscript received 1 Nov 80) pp 1104-1108

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[Abstract] Specialists carried out extensive geological investigations of the Red Sea rift during the 30th voyage of the scientific research ship "Akademik Kurchatov" using the "Paysis-XI" manned abyssal vehicle. During the course of the expedition there were 30 dives of the vehicle to depths from 80 to 2030 m. The nature of work with such craft requires that it be preceded by work from scientific research ships, providing general information on geological structure against which detailed work can be carried out. Accordingly, prior to work with the "Paysis-XI" a multisided geological-geophysical survey was carried out with use of echo sounding, continuous seismic profiling and magnetometry in a small sector of the central part of the Red Sea. Survey data were used in preparing a detailed bathymetric chart of the polygon. In this work with the "Paysis" a precise control of the craft's position was carried out using a hydroacoustic navigation system employing bottom beacons, affording the possibility of tracking the underwater movement of the vehicle and correcting movements from aboard the supporting ship. Figure 1 in the text is a block diagram of the hydroacoustic navigation system. Depending on relief, different methods were employed for movement of the vehicle near the bottom. The observer, with the rather good water transparency in the Red Sea, was able to see through the window a zone with a width of 20-25 m during movement of the craft at a distance of 8-10 m from the bottom. This method was useful in studying the geomorphology of the investigated region. However, at such a distance microrelief details are lost and the type of rock making up the sea floor can be determined only approximately. For a more detailed study of the geological structure of the rocks and microrelief the vehicle usually moves at a distance of 2-2.5 m from the bottom. During the Red Sea expedition the vehicle was used in obtaining more than 10 hours of video recordings and about 1000 high-quality photographs were obtained showing characteristic relief forms and geological formations in the rift zone. Another important source of geological information when working with such underwater craft is collection of geological samples from the sea floor. The samples are collected by means of manipulators, with the samples being stowed in a special bunker. During this expedition 59 samples with a total weight of more than 1 ton were collected. The largest sample, of pillow lava, weighs 83 kg. During one dive the craft delivered up to 200 kg of geological samples from the bottom. Figures 2.

[75-5303]



## EVALUATIONS OF POLARIZATION COEFFICIENT AND ENERGY SPECTRA FOR INTERNAL WAVES IN OCEAN

Moscow OKEANOLOGIYA in Russian Vol 21, No 6, Nov-Dec 81 (manuscript received 25 Jul 80, after revision 7 Apr 81) pp 996-1000

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[Abstract] A comparison of theoretical and experimental results relating to the polarization properties of the wave field in the ocean in the range of long-period internal waves is presented. The fundamental characteristic for such a comparison is the value of the rotation coefficient  $K_{rot}$ . The values of this parameter, computed on the basis of the selected linear model of internal waves and on the basis of the results of an empirical spectral analysis of observational data in the frequency range of interest, make it possible to judge the degree of approximation of the corresponding linear model to description of the studied wave field and to make a quantitative evaluation of the nonclosure ("noise") of such an approximation. The study is based on an analysis of a considerable number (about 2000) records of horizontal velocity obtained during measurements of currents with BPV and TsITT automatic recorders at buoy stations in the open ocean during the experiments Atlantic POLYGON-70, GATE-74 and POLYMODE. All the constructed curves are characterized by a maximum in the neighborhood of the inertial frequency and a local maximum at the frequency of the semidiurnal tide. The polarization coefficients computed on the basis of experimental data are usually lower than the corresponding theoretical curves. At the inertial frequency the polarization levels are close to the theoretical values; for the semidiurnal tide in most cases there is also a correspondence to the theoretical values. Using these data, on the basis of the hypothesis of nonpolarization of the noise component, a method is proposed for its discrimination and precise evaluations are obtained for the frequency spectrum of the field of horizontal current velocity in the range of internal waves. In the entire investigated frequency range linear models of free oscillations can satisfactorily describe only inertial and semidiurnal tidal disturbances. Within the framework of a definite quite broad class of linear models it was found that with respect to their contribution to energy only inertial and semidiurnal tidal movements exceed the "noise" level. Figures 2; references: 1 Russian, 3 Western.

[75-5303]



## INTERACTION OF INTERNAL WAVES AND CHANGE IN FLUID STRATIFICATION

Moscow OKEANOLOGIYA in Russian Vol 21, No 6, Nov-Dec 81 (manuscript received 13 Feb 80, after revision 3 Apr 80) pp 978-982

KONONKOVA, G. Ye., POKAZEYEV, K. V. and GANOPOL'SKIY, A. V., Moscow State University imeni M. V. Lomonosov

[Abstract] One of the physical mechanisms responsible for forming the density field is the destruction of internal waves. This article is devoted to an evaluation of the different mechanisms involved in the destruction of internal waves leading to a change in density stratification. An experiment was carried out in a glass flume with a length of 5 m, a height of 0.6 m and a width of 0.6 m. A slope was placed at the end of the flume for causing the extinction of internal waves. The internal waves were generated by a wave generator in which the plate exciting a wave had a horizontal axis of rotation situated at the center of the transition layer separating fluids of different density. The period of oscillations varied from 4 to 20 sec, the length of the internal waves was from 20 to 160 cm and the mean amplitude was from 0.5 to 2.0 cm. The lower layer of fluid was a solution of salt in water; the upper layer was fresh. The layer of intermediate salinity was dyed. The thickness of the dyed layer of fluid was 1-2 cm. In determining the vertical density distribution 50-ml samples were taken at 8-10 points vertically before and after the experiment. The parameters of internal waves in the stratified fluid satisfy the condition of development of intermode instability of internal waves. A degeneration of the first mode of the internal wave and the formation of the second mode was observed. The destruction of internal waves leads to a change in density stratification. On the basis of these experiments it can be postulated that the potential energy of the stratified fluid increase because the internal waves undergoing destruction perform work against buoyancy forces. The destruction of the first mode of internal waves occurs as a result of the development of intermode interactions and the transfer of energy of the first mode excited by the external source to higher-order modes. Figures 2, tables 1; references 6: 5 Russian, 1 Western.  
[75-5303]

UDC 550.83(265.3)

## GEOPHYSICAL INVESTIGATIONS IN SEA OF OKHOTSK

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: GEOLOGIYA I RAZVEDKA in Russian No 1, Jan 82 pp 80-87

MOSKVINA, N. L., BEREZHNYAYA, L. T. and TELEPIN, M. A., Scientific Production Combine "Soyuzgeofizika"

[Abstract] In the summer of 1978 specialists of the All-Union Scientific Research Institute of Geophysics carried out highly precise gravimetric (mean square error  $m = 3.0$  mgal) and magnetic ( $m = 1 \gamma$ ) surveys in the waters of the Sea of Okhotsk.

It is characteristic of the gravitational and magnetic fields of this region that they are correlated with geological structure. Combined highly precise gravimetric and magnetic data made it possible to refine the details of structure in the Sea of Okhotsk region. These materials were particularly informative in places where seismic prospecting is carried out. Profile KG-4, running meridionally from north to south through the central part of the Sea of Okhotsk, is about 550 km in length. The profile intersects the Institute of Oceanology Rise, Makarov downwarp, USSR Academy of Sciences Rise and then runs into the Kurile Basin. Figure 1 is a geological-geophysical section along profile KG-4. The examination of the gravitational and magnetic fields along profile KG-4 reveals a diversity in the structure of the investigated region. The entire profile can be divided into three parts. The northern part to  $x = 230$  km is characterized by a crust of the continental type. The top of the "granite" layer, traced on the basis of data from gravimetric prospecting, in general agrees with data from seismic prospecting. Magnetically disturbing bodies for the most part are interpreted as faults, but in large part are not accompanied by changes in the density of the material. An especially important fault according to data from magnetic prospecting is detected in the region  $x = 200$  km. The second part, to  $x = 370$  km, is characterized by a very complex geological structure. The gravitational field in this sector gives some basis for postulating the rising and intrusion of heavy mantle material into the lower part of the basement. The magnetic field in this sector is calm, except for the region  $x = 280$  km, where it is possible to postulate the penetration of heavy and magnetically active matter into the sedimentary layer. The third part, the southern segment of the profile, has a crust of a suboceanic type. Magnetic prospecting data in the northern half of this sector reveals a number of faults penetrating into the sediments, and in the southern part--intrusive bodies in the basement not expressed in the gravity field. The data indicate that the entire region through which profile KG-4 passes is a zone of intensive reworking of the earth's crust. Figure 2 is a geological-geophysical section along profile OP-12. This profile intersects the Kurile Basin in a direction NW-SE. In the seismic section the Kurile Basin, characterized by a crust of the oceanic type, is bounded on the northwest and southwest by faults separating this block from the continental margin with a crust of the continental type and from an island arc with a crust of a subcontinental type. The densities determined on the basis of seismic velocities reveal a homogeneity of crustal layers in a horizontal direction and an inhomogeneity of the upper mantle. On the basis of these data it can be assumed that the region intersected by these profiles is an active region. With respect to tectonics, the Kurile Basin differs substantially from the abyssal sector of the shelf adjacent to it on the north. Whereas the shelf is characterized primarily by dislocations, the Kurile Basin is characterized primarily by large intrusions of differentiated composition with direct and inverse magnetization, probably with a complex, multistage history of formation. The weak expression of intrusions in the gravitational field indicates their good isostatic compensation and confirms the high mobility of matter in this region. Figures 2.

[94-5303]

## DEVELOPMENT OF 'SYNOPTIC METHOD' IN OCEANOGRAPHIC RESEARCH

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 5: GEOGRAFIYA in Russian No 1, Jan-Feb 82 (manuscript received 24 Jun 81) pp 16-20

DOBROVOL'SKIY, A. D. and SEVEROV, D. N.

[Abstract] Synoptic analysis has become a powerful tool for investigating weather and predicting atmospheric processes and phenomena. This method has not been developed in oceanology due to the lack of regular, synchronous observations and due to lack of a method for constructing generalized oceanological maps, like the synoptic charts constituting the basis of the synoptic method in meteorology. This article is devoted to an approach to solution of this problem, that is, development of a method for multisided representation of oceanological conditions with respect to temperature, salinity, density, pressure, distribution of dynamic depths and streamlines of geostrophic currents by a single synoptic chart. The proposed method for generalized representation of the characteristics of water masses and the movement of waters can be called isopycnic T,S analysis since its basis is an examination of the topography of isopycnic surfaces and an analysis of pressure along the T,S curves and with depth with retention of a correlation in the form  $T = f(S)$  at such isopycnic surfaces. In order to construct a synoptic chart on which each of the isolines would characterize water masses and the movement of waters it is necessary to solve the problem of combining two methods: analysis of water masses in space coordinates and the dynamic method for investigating currents. Density, computed from temperature and salinity in hydrostatic and geostrophic approximations, ensures representation of the dynamics of currents. However, density data can yield more information than is obtained at the present time. The authors endeavor to demonstrate this for both the method for investigating currents and for the method for analysis of water masses, the connecting link between which is the isopycnic surface. With use of the synoptic method in oceanological research extensive possibilities will be afforded for carrying out an analysis of the formation, propagation and transformation of water masses for analysis of structures in the frontal zones in the world ocean, for discriminating zones of convergence of currents and water masses at intermediate and deep horizons, that is, conditions will be created for development of synoptic analysis of the dynamics of water masses. Figures 1; references 10: 7 Russian, 3 Western. [90-5303]

UDC 551.466.2

## FEATURES OF SPECTRAL CHARACTERISTICS OF VELOCITY FIELD OF WAVE MOVEMENT IN SEA SURFACE LAYER

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 17, No 12, Dec 81 (manuscript received 4 Jan 81) pp 1310-1317

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[Abstract] An experimental study was made of the velocity field in the upper layer of the sea at depths up to 3 m from the level of the undisturbed surface. All data were obtained as a result of synchronous measurements of the surface rise

and the three orthogonal components of the velocity of water movement at one or two horizons--1.2 m and 2.25 m. Waves were measured using a capacitance-type wave meter and velocity was measured using reversing propellor-type sensors mounted on a stationary mast located in an open region of the Black Sea at a distance of 300 m from the shore at a depth of 15 m. The length of the series was 1500 points, the discreteness of measurements was 0.2-0.25 sec and the number of degrees of freedom of the spectral evaluations was about 40. The characteristics of the wave meter and the processing method made it possible to obtain reliable evaluations of the surface rise spectrum in the frequency band up to 2 Hz. The article demonstrates that the relationships of linear spectral theory are satisfied in the region of the principal energy-carrying frequencies of waves and are impaired in the high-frequency region. The reasons for these deviations are discussed. The influence of the drift current and the kinematic effect of modulation of short waves by long waves are evaluated and a comparison with experimental data is given. Figures 5, tables 1; references 15: 6 Russian, 9 Western. [81-5303]

UDC 551.466.82

#### GROUPS OF INTENSIVE INTERNAL WAVES IN SEA SHELF ZONE

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian Vol 17, No 12, Dec 81 (manuscript received 19 May 80) pp 1302-1309

IVANOV, V. A., KONYAYEV, K. V. and SEREBRYANYI, A. N., Marine Hydrophysical Institute, Ukrainian Academy of Sciences, and Acoustic Institute

[Abstract] Since the development of the thermocline and its vertical fluctuations in the shelf zone are characterized by a number of patterns of behavior, the authors made long-term observations of the thermocline on the Caspian Sea shelf during summer at a point with a depth of 36 m. A bathythermograph was the principal tool used in the vertical soundings. Internal waves in the thermocline were measured using temperature sensors with a length of 5-10 m which were distributed in depth. The sensors measured the mean temperature of the studied water layer vertically and virtually linearly registered the vertical movements of the thermocline with a relatively stable transfer coefficient which was periodically measured by raising and lowering the sensor by 0.5-1 m. In most cases temperature fluctuations were registered by 4-8 sensors distributed horizontally within an area measuring 20 x 60 m. The spatial-temporal spectral analysis of these data makes it possible to determine the period, length, direction and velocity of wave movement. Against the background of a slow rise of the bottom thermocline there is sporadic appearance of sharp rises accompanied by groups of large internal waves. Nine different events of this type were observed and are analyzed here. The temperature structure of the water layer in the shelf zone of the sea during summer is characterized by an alternation of periods of intense storm mixing and periods of the development and intensification of the thermocline under the influence of solar heating and an inflow of cold water along the bottom. The inflow of cold water, leading to the formation and slow rising



of the clearly expressed bottom thermocline, arises under the observed conditions due to the removal of wind stress or the evening-out of atmospheric pressure after a storm and the subsequent restoration of static equilibrium of the water layer. The most intense rises with groups of large short internal waves relate to the beginning of the slow rise. The waves created at the edge of the sharp rise of the thermocline and moving together with this edge have a greater phase velocity in comparison with the velocity of free linear waves of this same length. With increasing distance from the front the phase velocity of the waves in groups decreases to values determined by the dispersion relationship. Figures 7, tables 1; references 16: 6 Russian, 10 Western.

[81-5303]

UDC 551.466.6

#### NUMERICAL INVESTIGATION OF CORRELATION BETWEEN DIRECTED RADIATION OF LONG WAVES AT SEA SURFACE AND DIMENSIONS OF LINEAR SOURCE

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 17, No 12, Dec 81 (manuscript received 10 Mar 80) pp 1290-1301

KRONIN, Yu. A.

[Abstract] The objective of this study was an investigation of the formation and evolution of zones of directed radiation of long waves as a function of the relationship of horizontal dimensions of a linear focus. The source of disturbance used in the study was an initial stationary level rise in the form of a zone of the length  $L_0$  and the width  $2\ell_0$ ; adjacent to both ends are semisinusoidal half-domes which in the horizontal plane have the form of a semicircle. Eight versions of a linear source were investigated. Seven of these had identical cross sections stipulated by a positive semisinusoid with an amplitude assigned the value unity along the entire zone but differing in the  $\bar{L}_0$  values (0, 2, 4, 6, 8, 14, 20) ( $\bar{L}_0 = L_0/\ell_0$ ). The version with  $\bar{L} = 0$  is represented by an axisymmetric dome and therefore it was defined as an independent variant and was designated as a "point source." Proceeding on this basis, the author analyzed the possibility of using the stationary phase method for studying the directivity of propagation of these waves from individual real sources in the Kurile-Kamchatka zone. It is shown that failure to take into account the influence of the ends of the focus with some forms of stipulation of the initial rise can lead to both a quantitative and qualitative discrepancy in modeling results. It was established that the increase in amplitudes of maximum crests has some limit governed by the dimensions of the focus. The results are compared with the wave pattern for an axisymmetric source. Empirical expressions are derived for approximate computations. Figures 5; references 10: 7 Russian, 3 Western.

[81-5303]



## SEVENTH PLENARY SESSION OF WORKING GROUP ON OCEANIC OPTICS

Moscow OKEANOLOGIYA in Russian Vol 21, No 6, Nov-Dec 81 pp 1138-1140

SHIFRIN, K. S.

[Abstract] The 7th Plenary Session of the Working Group on Oceanic Optics was held in Tallinn during the period 28-30 October 1980. The conference was organized by the Estonian Academy of Sciences and the Working Group on Oceanic Optics of the Commission on Problems of the World Ocean, USSR Academy of Sciences, at the base of the Institute of Thermal Physics and Electrophysics of the Estonian Academy of Sciences. The conference was attended by 180 persons; 125 reports were presented, grouped in six sections. Seventeen reports were given in the section on remote methods for studying the sea medium. A review report by K. S. Shifrin, entitled "Remote Methods for Investigating the Ocean," consisted of two parts. The first gave new results obtained in a study of the ocean from space. Level measurements indicated that the relief of the ocean surface is very complex, with hills and depressions. Direct measurements of temperature of the ocean surface indicated that the isotherms have a complex configuration, there are a great many temperature eddies and it is possible to observe their development, movement and gradual disappearance. The coincidence of absolute radiation temperatures, now obtained from standard artificial earth satellites and shipboard observations, is still unsatisfactory; the standard deviation is  $0.6^{\circ}\text{C}$  (with a spatial range of variability  $30^{\circ}\text{C}$ ). Measurements of the radiation balance components of the ocean-atmosphere system made it possible to refine the meridional transfer of heat by ocean currents. It was found that in the temperate latitudes the new mean annual values are 4-5 times greater than the old. In the tropical region oceanic transfer is substantially greater than atmospheric transfer. There was also a discussion of methods for study of the content of chlorophyll from space, as well as internal waves and petroleum films. The second part of the report dealt with optical problems related to the development of remote methods for studying the ocean: the masking role of atmospheric haze and methods for its exclusion, the role of surface waves, films, content of dissolved and suspended substances. A total of 35 reports were presented in the section on optical properties of natural waves. A review report entitled "Experimental Investigations of Fluorescence in the Ocean" was presented by G. S. Karabashev. A report by K. A. Mokiyeveskiy examined the correlation between the radiation and optical properties of internal water bodies and their structure. A report by Yu. A. Prokhorenko and G. G. Nauymin, entitled "Influence of Deep Bottom Relief on Water Transparency in the Upper Layers of the Ocean," noted that the spatial distribution of transparency in the upper layers of the ocean duplicates ocean floor relief. Several hypotheses were expressed for explaining the phenomenon. They also postulate that the observation of underwater mountains through a great thickness of water, reported by cosmonauts, in actuality was observation of transparency spots associated with relief. There were 14 percent in the third section, on light fields in natural waters. It was noted in a review report by L. S. Dolin, entitled "Theory of the Light Field in the Sea," that the numerous specific tasks with which specialists in hydrooptics are concerned can be rigorously formulated within the framework of the general approach of the stationary or nonstationary theory of radiation transfer with an appropriate choice of sources and boundary

conditions. Among the 19 reports in the fourth section, on optics of the sea surface, were two reports by A. G. Luchinin, "Some Features of the Optical Transfer Function of a System for Observation Through the Wave-Covered Sea Surface in the Case of a Small Base" and "Fluctuations of the Light Field Emerging From Beneath the Wave-Covered Sea Surface" and a report by M. Kh. Rafailov entitled "On the Stochastic Structure of the Light Field in Water After Interaction of Radiation With a Sector of the Wave-Covered Sea Surface." Two review reports were presented on atmospheric optics over the sea (a total of 18 reports were presented in this fifth section). O. A. Avaste, in a report entitled, "Problems in Sea Spectral Actinometry," examined and compared different optical models of the atmosphere over the sea proposed by different authors and used at the present time. For the most part the models differ with respect to vertical and spectral variability of the coefficient of aerosol attenuation. O. A. Yershov, in "Optical Investigations of Sea Aerosol," cited data on the features of structure and microstructure of marine aerosol and told about a simple method for determining the submicron and large-droplet fraction in the atmosphere over the sea. The sixth section, on instruments and observation methods (23 reports), included a review report by U. K. Veysmann and K. A. Erme entitled "Absolute Calibration of Instruments for Measuring the Optical Radiation of Natural Features." The report gave a detailed exposition of the method for calibrating radiometer-brightness meter instruments developed at the Institute of Astrophysics and Atmospheric Physics, Estonian Academy of Sciences. The authors used a segment of red-hot tungsten filament as the standard radiation source. In a summary it was concluded that in the implementation of optical work there are a number of difficulties: there are virtually no regular multisided optical voyages into different regions of the world ocean; as before, there are no standardized sets of instruments; remote work, especially with aircraft, is rarely accompanied by simultaneous measurements at sea; there are few studies on the matrix of scattering of natural waters and on the polarization characteristics of the light field; there are few studies devoted to investigation of the characteristics of sea aerosol, an active participant in the process of interaction between the ocean and the atmosphere.

[75-5303]

UDC 552.302.7(266+267)

#### MINERAL COMPOSITION OF FERRODIORITES OF MACQUARIE SUBMARINE RIDGE

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA GEOLOGICHESKAYA in Russian No 12, Dec 81 (manuscript received 15 Jul 80) pp 56-62

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[Abstract] Samples of gabbro and ferrodiorites were collected on the 16th voyage of the scientific research ship "Dmitriy Mendeleev" during trawling somewhat to the south of Macquarie Island. This material indicated that in the studied region there is an intensively differentiated gabbroidal intrusion of the Skaergaard type. The most interesting of these rocks were the samples of ferrodiorites,

whose total  $\text{Fe}_2\text{O}_3$  content attains 27%. The analysis of the mineral composition of these rocks, unique for the ocean, made it possible to trace the paths of evolution of the tholeiitic magma in the process of its differentiation in the oceanic crust. The ferrodiorites have a clearly expressed taxitic texture expressed in an extremely nonuniform distribution of large crystals of rock-forming minerals. The latter are represented by plagioclase, monoclinic pyroxene, olivine, hornblende, ore mineral and apatite. Table 1 gives the mineral composition of the ferrodiorites (% by volume); Table 2 gives the chemical composition of ferrodiorite minerals (% by weight). The above-mentioned minerals are discussed in detail, as well as titanomagnetite. The study of these minerals indicated that for the most part they correspond to the mineral paragenesis of ferrodiorites of the Skaergaard intrusion and are differentiates of tholeiitic magma. The investigation of the ore minerals from the ferrodiorites also indicates their relationship to gabbroids and reveals a complex history of formation of this type of rocks. Figures 4, tables 3; references: 2 Russian, 3 Western.

[79-A-5303]

## TERRESTRIAL GEOPHYSICS

### BRIEFS

CRUSTAL-MANTLE SUPERDEEP DRILLING-- The USSR State Committee on Science and Technology has adopted an extensive program for the drilling of superdeep boreholes for investigating the earth's crust and upper mantle. Plans call for about 20 points for the storming of "geospace," one of which is situated in the territory of the Ukraine. Preparations have begun for the drilling of a borehole with a depth of 7000 m. Its site is near the village of Ivanovka in the Krivoy Rog region. It is planned that the interesting experiment be completed by the end of the five-year plan. The Krivoy Rog region -- one of the largest iron ore basins in the world -- was included in the national program for exploring the earth's depths for very good reasons. Here great reserves of raw materials are intensively worked for the metallurgical industry. The depth of the shafts already has exceeded a thousand meters and it has been demonstrated that it is economical to produce raw material to the 2,500-m level. Later it will become possible to obtain ore from still greater depths. In this connection it is necessary to determine the lower boundary of the iron ore formations. The Krivoy Rog borehole will make it possible to answer many questions related to the structure and evolution of the earth's crust and processes occurring in the depths. The collected data will be useful in developing a scientifically sound prediction of the distribution of ore and energy raw material, effective directions in geological exploration and reconnaissance in the coming decades. This information was supplied by the Ukrainian Telegraphic Agency RATAU. The Krivoy Rog borehole will help in obtaining data which are exceptionally valuable for science. Accordingly, a great body of scientists is taking an active part in the investigations. [Text] [Riga SOVETSKAYA LATVIYA in Russian 26 Dec 81 p 2] 5303

CSO: 1865/72

## GRAVITATIONAL MODEL OF NORTHERN INDIAN OCEAN

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 261, No 4, 1981 (manuscript received 7 Apr 81) pp 840-843

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[Abstract] Actual information on deep structure of the Indian Ocean area is still very scarce. Crustal thickness has been estimated by the deep seismic sounding method at approximately 100 points; crystalline rocks of the oceanic crust were penetrated by drilling at 33 points. However, the Indian Ocean has an extremely complex structure. For this reason the authors endeavored to formulate a gravitational model of the northern part of the Indian Ocean using the limited data available. Modeling of  $\Delta g$  anomalies in a profile variant, without tie-in to seismic and drilling data, is rarely practiced, for the most part for qualitative evaluations, since in the absence of a priori equivalence limitations the choice of a density model seems irrational. However, it is possible to analyze the entire set of equivalent variants of the model, computing the upper and lower limits of the interval in which the equivalent solutions fall. In such computations it is of the greatest interest to trace changes in the nature of the limits of this interval with a change in the type of structure. This method was used in constructing a three-dimensional density model on the basis of the difference field  $\Delta g_R = \Delta g_{R \text{ free air}} - \Delta g_{\text{rel}}$ , where  $\Delta g_{\text{free air}}$  are the measured gravity values in a free air reduction,  $\Delta g_{\text{rel}}$  is the bottom relief or surface relief effect. Field values averaged for  $1^\circ \times 1^\circ$  squares were used as  $\Delta g_{\text{free air}}$ . The method as applied is described in detail and illustrated in a local example. A quantitative analysis was made of the gravitational difference field of the Indian Ocean over all structures between  $0-20^\circ\text{N}$  and  $50-90^\circ\text{E}$ . Figure 2 is a map of interpretation of the  $\Delta g_R$  field constructed on this basis. Checking of the model in sectors where there are additional data indicates that reliable delineation of significant geological structures is possible. Figures 2; references 11: 5 Russian, 6 Western.

[83-5303]



## SUBTRACTING FIELD OF MULTIPLE WAVES IN REFLECTED WAVES METHOD BY SOLVING INVERSE AND DIRECT DYNAMIC PROBLEMS IN SEISMICS

Novosibirsk GEOLOGIYA I GEOFIZIKA in Russian No 12, Dec 81 (manuscript received 12 Dec 80) pp 112-121

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[Abstract] The authors propose a regularizing single-channel filter making it possible to avoid the difficulty associated with inexact solution of the inverse problem in the subtraction of multiple waves by the method of solution of the direct and inverse dynamic problems (SMV-DIP). The basis for this filter was the idea of replacement of the experimental wave field by the theoretical wave field predicted by the methods of solution of the inverse and direct dynamic problems in seismics and its use as primary material in the further subtraction of multiple waves by the DIP-SMV method, as well as the idea of writing direct and inverse transforms based on the difference solution of the one-dimensional direct and inverse dynamic problems. In text examples the article examines the influence of shape of the pulse, its frequency and levels of regular and irregular noise on the stability of filter operation when the wave field  $U_{exp}(t)$  (obtained at the earth's surface for a central ray) has been reduced to a plane wave front  $U_{exp}^p(t)$ . Criteria are found with which the filter functions stably. The SMV-DIP method for the subtraction of multiple waves is applicable in observations of the wave field both at the surface and at internal points in the medium. Sources of the explosive and vibrational types can be used. The greatest effect can be obtained from the proposed method when studying the wave field formed by a complexly structured medium covered above by a horizontally stratified sedimentary layer. The use of the SMV-DIP methods can be effective in seismic work at sea when noise of the reverberation type is suppressed. Figures 6; references 7: 5 Russian, 2 Western. [95-5303]

UDC 550.831

## RESULTS OF MODELING OF DEEP STRUCTURE OF EARTH'S CRUST IN NORTHWESTERN TURKMENISTAN ACCORDING TO COMBINED GRAVIMETRIC AND DEEP SEISMIC SOUNDING DATA

Ashkhabad IZVESTIYA AKADEMII NAUK TURKMENSKOY SSR: SERIYA FIZIKO-TEKHNICHESKIKH, KHIMICHESKIKH I GEOLOGICHESKIKH NAUK in Russian No 6, Nov-Dec 81 (manuscript received 18 Dec 80) pp 82-87

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[Abstract] A gravitational model of northwestern Turkmenistan was constructed along three deep seismic sounding profiles. The geometry of the seismic boundaries, characteristics of distribution of velocity parameters and detected tectonic

dislocations served as a basis for discriminating gravitating factors. The seismic profiles were investigated in different years by different parties and as a result the profiles were not tied in with one another. For this reason gravimetric models were constructed for each of the profiles separately and on the basis of their comparison and analysis an attempt was made at the mutual tie-in of the profiles. The thickness of the crust along the profiles was variable; its thickness increases from 35 to 45 km along the line. The principal boundaries clearly discriminated on the basis of seismic characteristics on all the profiles are the surface of the basement and the bottom of the crust. Between these there are poorly expressed seismic horizons occupying an intermediate position between the sedimentary layer and the upper mantle (with respect to velocities). Seismic velocity data were used in determining the densities of the rocks making up the crust at different depths and within the limits of different tectonic elements. Initially the gravitational effect was determined using a model based on a number of assumptions; the exact approach is fully described. Figure 1 is a section of the crust along one of these profiles; Figures 2 and 3 are corresponding sections along other profiles. Among the discriminated density discontinuities the principal gravitational effect is everywhere created by the relief of the Moho and a less significant effect is created by the relief of the basement surface. Computations for several variants of deep crustal structure along deep seismic sounding profiles for the territory of northwestern Turkmenistan in general indicated that the crust is inhomogeneous vertically and horizontally in both the upper and lower parts; the greatest lateral density heterogeneity is characteristic of the top of the basement to a depth of 10 km; at greater depths the inhomogeneity decreases. The principal sources of the gravity anomalies are density inhomogeneities of the sedimentary layers and top of the basement, the relief of the principal density discontinuities in the crust, density inhomogeneities in the "granite" layer and possibly reduced density in the upper mantle. Figures 3; references: 5 Russian. [79-5303]

UDC [551.15:550.834.32](477.7)

# UPPER MANTLE STRUCTURE IN NORTHERN BLACK SEA AREA ACCORDING TO DATA FROM DEEP SEISMIC SOUNDING

Kiev DOKLADY AKADEMII NAUK UKRAINSKOY SSR, SERIYA B: GEOLOGICHESKIYE, KHIMICHESKIYE I BIOLOGICHESKIYE NAUKI in Russian No 11, Nov 81 (manuscript received 6 Aug 81) pp 28-30

SOLLOGUB, V. B., corresponding member, Ukrainian Academy of Sciences, BORODULIN, M. A. and SOLOGUB, N. V., Geophysical Institute, Ukrainian Academy of Sciences

[Abstract] In 1979 the Geophysical Institute of the Ukrainian Academy of Sciences and the "Ukrgeofizika" Combine began investigations along geotraverse VI by the continuous profiling method with a tied-in system of travel-time curves with an interval of 200 m between the centers of the groups of seismic detectors. This made it possible to register seismic oscillations of an adequate intensity at a

distance of 300-400 km. This made it possible in turn to judge the structure of the upper mantle with a high degree of reliability. This article gives the results of investigations along the northeastern part of geotraverse VI in the northern Black Sea area (between Saki and Brest). The most interesting wave pattern was at a distance exceeding 250 km from the shot point. In this region in the successive arrivals there were three types of waves registered ( $\Gamma_0, \Gamma_1, \Gamma_2$ ) with an extent up to 60 km. These appear to be reflected waves. The  $\Gamma_0$  wave is characterized by a low intensity. At 280-290 km from the shot point the  $\Gamma_0$  wave approaches the first arrivals and then only the  $P^M$  wave is traced. The intensity of the  $\Gamma_1$  and  $\Gamma_2$  waves is considerably greater than for the  $P^M$  waves, making their correlation reliable. The  $\Gamma_1$  and  $\Gamma_2$  waves are multiphase (from 3 to 5 phases); the period of oscillations is 8-12 Hz. In the sector Skadovsk-Vinnitsa a system of direct and reverse travel-time curves was obtained making it possible to construct a seismic section. The Moho in the southeastern and central parts of the profile lie virtually horizontally at depths of 35-40 km. In the northwestern part there is a clearly expressed plunging of the M discontinuity to 60 km along a number of faults. Below the Moho within the northern Black Sea area there are two inhomogeneities in the upper mantle in the form of layers with reduced velocities. The first layer, situated at depths of 50-60 km, is characterized by a relatively reduced velocity (8.0 km/sec). Its structural position and velocity characteristic were determined quite reliably. At depths of 70-80 km there are two seismic discontinuities which correspond to strong reflected waves. The mantle layer between these two discontinuities is also probably characterized by reduced velocities. The distribution of the energy of elastic oscillations is evidence of the presence of a definite channel in the lithosphere along which elastic waves are propagated with a minimum attenuation. This channel appears to pass through Vranich-Kishinev-Kursk-Ukhta and is evidently genetically associated with an uplifted part of the layer with reduced velocity. This rise is bounded by zones (faults) absorbing seismic energy. The seismic investigations along the Saki-Vinnitsa profile thus established the existence of a lithospheric rise which is traced in a north-easterly direction and which is characterized by reduced velocities of elastic oscillations. This rise is a singular channel for waves arising in deep earthquake foci in the Vranich region. Figures 2; references: 6 Russian.

[84-5303]

## MODEL OF STRUCTURE OF CRUST AND UPPER MANTLE ALONG CENTRAL ASIA-CAUCASUS PATH

Tbilisi SOOBASHCHENIYA AKADEMII NAUK GRUZINSKOY SSR in Russian Vol 102, No 1,  
Apr 81 (manuscript received 26 Sep 80) pp 57-60

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[Abstract] In determining the dynamic parameters of strong earthquakes in Central Asia on the basis of records of Caucasian seismic stations it is necessary to select the optimum model of structure of the crust and upper mantle along the path Central Asia-Caucasus. The seismic waves registered on the seismograms are frequently distorted by microseisms and interference caused by the signal itself. There is a complex wave pattern and an investigation of waves with use of its time record or spectrum in the analysis of surface waves can be unreliable. However, the desired result can be achieved by an examination of a two-dimensional spectral-time representation called SVAN (spektral'no-vremennoy analiz--spectral-time analysis). Its basic principle is a replacement of one-dimensional representations of the signal  $f(t)$  by a two-dimensional spectral-time representation  $Y(\omega, t)$ .  $Y(\omega, t)$  characterizes the signal spectrum in the neighborhood of the frequency  $\omega$  at times close to  $t$ . The SVAN method involves linear filtering of the input signal  $f(t)$  by a set of narrow-band frequency filters in a representation of the spectrum of the filtered signal through its envelope and phase in the form of a function of time and the central frequency of the filter. The SVAN method gives good results in the discrimination of weak signals, separation of interference waves and in determining the dispersion of the group and phase velocities of individual harmonics. Due to the simultaneous resolution in time and frequency the SVAN method makes it possible to resolve signals with different frequency modulation laws. The SVAN method was used in an analysis of the record of surface Rayleigh waves registered from strong earthquakes in Central Asia occurring between 1970 and 1976 for the purpose of computing the group velocities of Rayleigh waves on the Central Asia-Caucasus path. The group velocities were computed for periods from 10 to 50 sec. The results indicated that the group velocities in small periods approximately in the range of 10-16 sec considerably vary. Records of long-period apparatus of the SD and SKD type at seismic stations in Georgia and Armenia were used. The investigated path along which the surface waves are propagated is characterized by a complex structure. Along the Central Asia-Caucasus path there are several zones with different crustal structure. A table gives the distribution of velocities of longitudinal and transverse waves, as well as density, as a function of depth  $z$ . In the model of a plane earth which was used it was possible to discriminate four principal layers with a total thickness of 45 km situated above the upper mantle: a sedimentary layer with a thickness of 3 km, a granite layer with a thickness of 12 km, an intermediate layer with a thickness of 10 km and a basalt layer with a thickness of 20 km. Figures 1, tables 1; references: 2 Russian.

[60-5303]



## EXPERIMENTAL INVESTIGATIONS OF NONLINEAR INTERACTIONS OF SEISMIC SURFACE WAVES

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 260, No 3, 1981 (manuscript received 27 Mar 81) pp 574-575

ALESHIN, A. S., GUSHCHIN, V. V., KREKOV, M. M., NIKOLAYEV, A. V., SOKOLOV, A. V. and SHALASHOV, G. M., Institute of Physics of the Earth imeni O. Yu. Shmidt, USSR Academy of Sciences, Moscow

[Abstract] In geophysics, in the development of methods for the excitation and reception of seismic waves and in the interpretation of data, the medium is usually regarded as linearly elastic. However, in the case of medium deformations greater than  $10^{-5}$  -  $10^{-7}$ , which are observed in the near zone of both natural and artificial seismic sources, nonlinear wave phenomena must be taken into account. The generation of combination frequency waves is a fundamentally new effect arising when medium nonlinearity is taken into account. Field measurements of the interaction of waves generated by SV-10/100 vibrational seismic sources were carried out for experimental evaluation of the effectiveness of combination interactions of seismic waves. This work was done in the autumn of 1979 in the Belorussian SSR. The seismogeological parameters of the upper part of the section were as follows: to a depth of 2.7 m--sandy loams with velocities of longitudinal waves 600 m/sec and for transverse waves--150 m/sec. The water table was at 2.7 m, below which the velocities of longitudinal waves increase to 1560 m/sec, whereas the velocity of transverse waves increases smoothly with depth. The mean velocities of the longitudinal and transverse waves characterizing the 80-m upper layer were  $\bar{V}_p = 1500$  m/sec and  $\bar{V}_s = 600$  m/sec. The seismic waves were excited independently by two SV-10/100 vibrators. Nonlinear distortions of seismic waves attaining tens of percent were registered in this experiment. The amplitudes of the combination waves exceeded by an order of magnitude the level of the nonlinear distortions of the apparatus. The vibrators were spaced 40 m apart. The reciprocal influence of the vibrators can be neglected since the level of the combination harmonics caused by nonlinearity of the sources could not exceed 1% of the amplitude of the initial waves. The observed level of the combination frequency waves is attributable only to nonlinear interaction of waves in the ground. The data collected in this experiment clearly show the high effectiveness of nonlinear interactions of seismic waves and the anomalously high values of parameters of nonlinear elasticity of ground. Figures 1; references: 3 Russian.

[57-5303]



## NEW CONCEPTS CONCERNING CRUSTAL STRUCTURE IN URALS ACCORDING TO DEEP SEISMIC SOUNDING DATA

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 260, No 6, 1981 (manuscript received 25 Mar 81) pp 1444-1447

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[Abstract] Until recently it has been generally accepted that the blocks in the earth's crust in the Urals discriminated on the basis of deep seismic sounding data are separated by subvertical deep faults. This belief has been reinforced by the fact that in the interpretation of deep seismic sounding data such work is usually done without proper allowance for various seismic criteria definitely indicating that in the earth's crust in this region there are major gently sloping disjunctive dislocations. The article includes a schematic seismogeological section of the crust revealing gently sloping disjunctive dislocations discriminated on the basis of an analysis of the initial section of the crust on the sublatitudinal profile Izhevsk-Ishim intersecting the central Urals. Most of these gently sloping disjunctive dislocations are developed in the crystalline part of the crust; some can be traced to the very bottom of the crust. The basic feature of these formations is that there are no direct structural relationships between them and the fault system which is widely manifested in the surface structure of the Urals. The results obtained along this profile are of more than regional importance. They also indicate the importance of discriminating sloping discontinuities in the crust in general and their use in developing concepts concerning its tectonic structure and development. Figures 1; references: 5 Russian. [56-5303]

UDC 550.834

## STATISTICAL PROPERTIES OF EVALUATIONS OF POLARIZATION PARAMETERS OF SEISMIC WAVE FIELDS

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ZEMLI in Russian No 11, Nov 81 (manuscript received 14 Aug 80) pp 27-44

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[Abstract] Polarization-kinematic analysis of three-component profile observations is the principal tool for determining the nature of interfering waves in complexly structured media, a means for localization of its tectonic features. The author here examines some methods for evaluating the polarization parameters of interfering seismic waves and clarifies the factors exerting a dominating

influence on the mean square errors in the evaluations. The first part of the paper gives a determination of the polarization parameters of arbitrary seismic oscillations; in the second part the emphasis is on evaluations of elements of matrix constructions describing the polarization properties of determined terms for a model with additive Gaussian noise (case of interference of a great number of waves) and an analysis of the statistical properties of the proposed evaluations; the third part of the paper examines evaluations not very critical to the interference of a small number of regular waves. The factors (energetic, correlation and spectral) exerting the dominating influence on the error are discussed in detail. The observed regularities can favor an increase in the reliability of determining the nature of waves and structures in complexly structured media. References 19: 17 Russian, 2 Western.  
[62-5303]

INVESTIGATION OF SPATIAL INHOMOGENEITIES OF BACKSCATTERING COEFFICIENT IN LOWER ATMOSPHERE

Moscow IZVESTIYA AKADEMII NAUK SSSR: FIZIKA ATMOSFERY I OKEANA in Russian  
Vol 17, No 11, Nov 81 (manuscript received 4 Aug 80) pp 1148-1154

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Academy of Sciences

[Abstract] The article gives the results of investigations of characteristics of inhomogeneities of the backscattering coefficient  $\beta$  applicable to laser sounding problems determined from aboard an IL-14 aircraft for a number of spectral intervals in the visible range to an altitude of 5 km. These experimental investigations of fluctuations of the backscattering coefficient were made using an apparatus based on a scheme with intersecting axes of the source and detector and with an observation angle of the scattered radiation  $176^\circ$ . The scattering volume formed by intersection of the source beam and the field of sighting of the detector was situated under the aircraft fuselage at a minimum distance of 1.5 m and had an extent of 2.5 m with a mean diameter of 20 cm. The source used was a pulsed xenon lamp which ensured a pulse repetition rate 10 Hz with a duration  $50 \mu\text{sec}$ . The receiving objective had a field of view  $1.5^\circ$ . The discrimination of spectral intervals was possible by the installation of interference filters with centers at the wavelengths 0.37, 0.55 and  $0.70 \mu\text{m}$  and a half-width of 20 nm in the detector. The experimental apparatus in actuality was a pulsed nephelometer with a fixed scattering angle which made possible the successive investigation of fluctuations of the backscattering coefficient in the visible range of optical radiation. The flights were made in the dark and twilight parts of the day over the territory of Western Siberia and Central Asia during the autumn season of the year with a mean air speed of 70 m/sec. The studies were made in a cloudless atmosphere; the surface range of visibility was monitored visually and varied in the range 15-20 km. It was found that the variation coefficient in the atmospheric surface layer is slightly dependent on wavelength, but at altitudes greater than 2 km it assumes high values in the red spectral region. The scales of the inhomogeneities  $\beta$  are several tens of meters. Recommendations are given on the optimum choice of wavelength in observation systems using  $\beta$  inhomogeneities. Figures 4; references 18: 9 Russian, 9 Western.  
[64-5303]

## ARCTIC AND ANTARCTIC RESEARCH

### 'PROFESSOR ZUBOV' DEPARTS FOR ANTARCTICA

Riga SOVETSKAYA LATVIYA in Russian 11 Nov 81 p 4

[Article by V. Chapluzhkin]

[Text] The steamer "Professor Zubov" of the Order of Lenin Arctic and Antarctic Scientific Research Institute has departed from the moorings of the Riga Ship Repair Plant of the USSR Ministry of the Maritime Fleet. This summer this Leningrad-based vessel made its 30th voyage, returning from the North Atlantic after observations of jet streams in the upper layers of the atmosphere. Scientists also registered bursts of solar radioemission and carried out a complex of aerometeorological, oceanographic and radiochemical investigations.

At the time of repairs in Riga the radionavigation equipment was replaced and a modern Soviet-produced radar set was installed to assist the navigator.

The next voyage of the "Professor Zubov" will be into the southern latitudes: the ship will participate in a new Soviet Antarctic expedition.

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